Determination of Velocity and Fault Geometry from Inversion of the 1994 Active-Source Larse Data Set

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## TECHNICAL ABSTRACT

We apply inversion methods to first-arriving P waves from explosive-source seismic data collected along Line 1 of the Los Angeles Region Seismic Experiment (LARSE) in order to determine a seismic model of the upper crust along the profile. Line 1 extends 165 km from Seal Beach, California, northeastward across the Los Angeles and San Gabriel Valley basins, the San Gabriel Mountains, and into the Mojave Desert. A 50 percent improvement in data fit over the preliminary model of Fuis et al. [1996] is achieved by deleting data for source-receiver paths with an excessive off-line distance component. We use resolution information to quantify the extent of blurring in the LARSE images to aid anomaly interpretation and identification of model artifacts. The blurring estimates are also used to smooth a damped least-squares images by a post-inversion filtering process that is constrained to preserve most of the original data fit (35-40 ms) while minimizing model artifacts. We compare damped least-squares (DLS), post-inversion filtered (PIF), and smoothing-constraint inversion (SCI) images using both real and synthetic data. A preferred PIF image includes larger-scale features observed in the SCI image and finer-scale features resolvable in the DLS inversion image that are consistent with a priori geologic information.

We interpret principal features in our models in terms of geology, including faulting, along LARSE Line 1. The maximum depth of relatively low-velocity sedimentary and volcanic rocks in the Los Angeles basin appears to be 8-9 km, whereas the maximum depth of similar rocks in the San Gabriel Valley is 4.5-5 km. A horst-like uplift of basement rocks occurs between the Los Angeles and San Gabriel Valley basins beneath the Puente Hills. The northeastern boundary of the San Gabriel Valley basin is imaged as a tabular, moderately north-dipping low-velocity zone which projects to the surface at the trace of the Duarte fault, the southernmost branch of the Sierra Madre fault system. At depth, this fault appears to be a suture between rocks of the

Peninsular Ranges and rocks of the San Gabriel Mountains. In the central and southern San Gabriel Mountains, velocity-depth profiles are consistent with intermediate-velocity mylonites overlying lower-velocity Pelona Schist along a shallowly dipping, concave-upward Vincent thrust fault. In the northern San Gabriel Mountains, between the Punchbowl and San Andreas faults, relatively low velocity is observed to a depth of several kilometers consistent with the presence of Pelona Schist to this depth in this fault-bounded block. Tomography does not provide a definitive dip for the San Andreas fault but, combined with other LARSE results, is consistent with a steep northeast dip (~83 degrees). Rocks at several kilometers depth in the Mojave Desert appear to be higher in velocity than one would expect for the postulated presence of the Pelona Schist, but tomography can not resolve these velocities definitively.

**NON-TECHNICAL ABSTRACT**

We have analyzed active-source seismic data from the 1994 Los Angeles Region Seismic Experiment (LARSE) and have interpreted the crustal velocity structure in terms of composition from laboratory measurements of rock velocities. Our results from the modeling of LARSE Line 1 have provided detailed images of the upper 7 km of the crust, in particular along the high-resolution segment traversing the San Gabriel Mountains and San Andreas fault. We have provided a means of estimating image blurring to aid interpretation and for use in a post-inversion filtering (PIF). Smoothing applied as a PIF operation provides images ranging between "minimum feature" smoothing-constraint inversion and damped least squares inversion images. These images provide valuable static corrections for reflection processing and teleseismic studies, can provide velocity constraints for strong motion studies and can be used with laboratory rock measurements for interpretation.